WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

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Volume VI, No. 16 July 3, 1961

* SNAP RADIOISOTOPE PROGRAM

The apparently highly successful launch of the Navy's Transit IV-A navigation satellite has proven once again that with time, patience and persistence, Government officials can sometimes be persuaded to keep pace with science and engineering.

Any one of the three satellites placed into orbit by a Thor-Able-Star rocket during the past week represents significant achievement. The fact that all three were launched by a single booster clearly demonstrates the Navy's outstanding capabilities in the space field -- capabilities which some Pentagon officials have tried to eliminate. The multiple launch technique, in addition to its economy factors, may prove of great value in the so-called passive communications network now being planned.

The fact that for more than a year scientists and engineers have been trying to win approval for the use of auxiliary nuclear power in a satellite testifies to the difficulties encountered when technical capabilities clash with official timidity. It took extreme pressure from Congress, from a small group of dedicated and technically-trained project directors, from industry and from other "outside" sources before SNAP (Systems for Nuclear Auxiliary Power) could be tested in space.

✓ Long History: The SNAP system is based on the principle of thermoelectric conversion discovered almost 150 years ago in Germany. In 1952 an initial feasibility study by the Rand Corporation, known as Project Feedback, was sponsored by the Air Force and the Atomic Energy Commission. The AEC now states that the need for atomic reactor power to furnish sufficient long-term power for proposed satellite missions was clearly indicated in this study. AEC then agreed to a Defense Department request to explore the possibilities of using both radioisotopes and reactors as heat sources. Here is the official version of SNAP developments to date:

✓ SNAP-1: In March 1956, the Atomic Energy Commission initiated a low level effort with the Nuclear Division of The Martin Company, Baltimore, Maryland, for the development of a radioisotope-fueled space power unit. After a year of studying the suitability and availability of potential radioisotope fuels, both waste fission products and especially irradiated materials, cerium 144 was selected to be the fuel used in the development program.

Conversion of the heat of decay of the cerium 144, which was to be contained in two cylindrical fuel blocks each about a foot long and four inches in diameter, was to be accomplished by boiling liquid mercury and allowing the mercury vapor to expand through a small turbine which turned an alternator. Power plant design specifications of 500 watts electrical for a 60-day mission life were decided upon and Thompson Products, Cleveland, Ohio, was chosen under subcontract to The Martin Co. to develop the mercury turbogenerator equipment. The program was given the designation of SNAP-1 and delivery of the first completed unit was scheduled for Sept. 1959.

* SNAP RADIOISOTOPE PROGRAM (Continued)

✓ SNAP-3: In addition to the full development program to produce a cerium 144-fueled SNAP-1 unit using rotating conversion equipment, several subcontracts were let under the basic Martin Company radioisotope contract to develop advanced thermoelectric and thermionic heat to electricity conversion devices that could be used with radioisotope heat sources. Generators of this type would be truly static and would not introduce gyroscopic action to space vehicles.

Work was started in 1958 on two thermoelectric demonstration devices, one to be built by the Westinghouse Electric Corporation, the other to be built by the Minnesota Mining and Manufacturing Company. Each company intended to use its own thermoelectric materials and fabrication techniques. In addition to these thermoelectric devices, development of demonstration thermionic units was undertaken under Martin subcontract by the Thermo-Electron Engine Corporation, Cambridge, Massachusetts, and United Electronics, Newark, New Jersey. This whole program to develop and demonstrate advanced energy conversion techniques was given the designation of SNAP-3.

The SNAP-3 program was quick to yield results when the Minnesota Mining and Manufacturing Company delivered a complete thermoelectric generator to The Martin Company in December 1958. The generator was designed to receive polonium 210 fuel capsules to be furnished by the Atomic Energy Commission's Mound Laboratory, Miamisburg, Ohio. Polonium 210, an alpha-emitter, was used because it was suitable and readily available. The Martin Company assembled and tested the complete generator in early January 1959, and delivered the unit to the Atomic Energy Commission. This proof-of-principle demonstration device produced 2.5 watts with a half charge of polonium 210 fuel and was first introduced to the world by President Eisenhower on January 16, 1959, as the SNAP-3 "atomic battery."

The successful demonstration of thermoelectric conversion when used in conjunction with a radioisotope heat source, as embodied in the SNAP-3 device, resulted in a reorientation of the parent SNAP-1, planned to use a cerium 144 heat source similar to those developed for the old SNAP-1 program but dispensed with rotating conversion equipment. Thermoelectric materials of the type used in the SNAP-3 device shown to the President would accomplish the heat to electricity continuously for a year rather than 500 watts of electricity for 60 days as was planned for SNAP-1. The power level would be 120 watts.

✓ Turbogenerator Program: The turboelectric portion of the SNAP-1 program has been transferred to the reactor development portion of the SNAP program where mercury conversion equipment of the same type was being developed by the same contractor, Thompson Products, for the SNAP reactor system. The SNAP-1 turbogenerator package has since been tested with mercury vapor under designed conditions and has operated far in excess of its test specifications.

In October 1959, the Department of Defense notified the Atomic Energy Commission that it considered SNAP-1A only as a backup for solar power for its military satellite programs. On this basis the Atomic Energy Commission decided to modify the SNAP-1A program to develop a high-powered ground demonstration unit. SNAP-1A was completed in June 1961 after making substantial contributions to the fields of thermoelectric generator fabrication and aerospace atomic safety.

✓ SNAP-7: Four prototype isotopic units fueled with strontium 90 are being developed for the Coast Guard and the Navy for use in coastal navigational aids and automatic weather stations. Each agency will receive 5-watt and 30-watt units. Delivery will start this fall. The units are designated SNAP-7A, B, C, and D.

* SNAP RADIOISOTOPE PROGRAM (Continued)

✓ SNAP-2: In the fall of 1955, the Atomic Energy Commission requested industry to bid on the development of a space reactor system for the Air Force's advanced satellite system. The proposals of Lockheed Aircraft Corporation, Palo Alto, California, and Atomics International, Canoga Park, California, were chosen from among 13 submitted. Low level support of both these reactor concepts was continued while the merits of the two systems received closer scrutiny. Finally the Atomics International concept was chosen in the spring of 1956 and was designated the SNAP-2 program.

The SNAP-2 program for developing a three electrical kilowatt unit has progressed to the point of testing a prototype reactor core at design power and temperature conditions in a special test facility. Mercury vapor turbogenerator conversion equipment is being developed by Thompson-Ramo-Woolridge, Inc., Cleveland, Ohio, under contract to Atomics International.

An atomic-electric power system that must start up automatically and operate unattended for a long period of time in space must have a sophisticated control system. Insuring the high quality of performance that is required will be possible only through the conduct of ground tests. The tests for SNAP-2 are to be conducted in an especially constructed $2 million facility called the SNAP Environmental Test Facility (SETF) at Santa Susana, California, completed in 1960. The SETF has been designed to permit the maximum of testing flexibility of fully atomic SNAP-2 systems. Provisions for remote manipulations and removal of all radioactive components including the reactor fuel elements have been incorporated in the design of the facility.

The first of the tests in SETF is designated SNAP-2 Developmental System S2DS test. It will have as its objective the gathering of system control and component response data at design operating conditions.

The next complete system test, SNAP-2 Package System (S2PS) test, will be that of a SNAP-2 system in a "flight-package" configuration. The third of the evolutionary system tests is SNAP-2 Flight System No. 1 (S2FS1) test. S2FS1 will be a ground demonstration of the final flight system. Three flight prototypes will be built, one to be tested as S2FS1, the other two to be available for flight demonstration.

✓ Metal Hydride Reactor: Until January 1959, the three electrical kilowatt SNAP-2 unit was the only space atomic reactor auxiliary power system under development by the Atomic Energy Commission. Since that time, two additional space power unit development programs have been started based on the metal hydride reactor technology developed under SNAP-2: - SNAP-8 to develop a 600 thermal kilowatt reactor (30 electrical kilowatt unit) and SNAP-10A to develop a 500 electrical watt atomic auxiliary power unit.

✓ SNAP-8: SNAP-8 is being developed in conjunction with the National Aeronautics and Space Administration. The NASA is developing the power conversion equipment and will accomplish the over-all system integration. The NASA contractor for this program is Aerojet-General Corporation, Azusa, California. The SNAP-8 program schedule includes the demonstration of 90 days system life by January 1964 and 10,000 hour successful life demonstration of a complete system by the summer of 1965. The Atomic Energy Commission plans to construct facilities for the testing program.

✓ SNAP-10: Conceptual design of a conduction-cooled 330 pound, 300 electrical watt reactor system using thermoelectric conversion was completed in 1959. The program was given the designation of SNAP-10. In 1960, the program was redirected to develop a convection-cooled system using the SNAP-2 reactor. This unit, designated SNAP-10A, will be capable of producing 500 watts at a system weight of less than 750 pounds. SNAP-10A will fit the power and weight requirements for an Air Force satellite system. This program is pointing towards flight demonstration in early 1963.

ROYALTY FREE PATENTS

Here is a new listing of Government-owned patents normally available for royalty-free licensing to U. S. organizations and individuals. Many such patents are being used or adapted for the military or commercial markets.

Subscribers interested in these patented inventions may write Service Department, Washington SCIENCE TRENDS, National Press Building, Washington 4, D. C. for Patent Number and Information on where to apply for free licensing.

- FABRICATING EXPLOSIVE MISSILES: In this invention, interwoven metallic strands are used to surround a thin wall inner shell -- acting as a restraining container.

- MAGNETIC CORE BINARY COUNTER: In this counter a single output is produced for two input pulses -- regardless of the time interval therebetween.

- POTENITOMETER INSULATING DEVICE: This invention covers a novel means for insulating potentiometers associated with aircraft fire control equipment such as computers and radars which must function at very high altitudes.

- LUBRICANT CONTAINING BORON: This patent covers a method of improving the performance of a halogenated hydrocarbon lubricant through the addition of boron nitride. Typical applications may include the propulsion units of torpedoes, rockets and guided missiles.

- POLYMERS: This patent covers compounds formed by an unusual chemical reaction and suitable for products useful in making fuel hoses, gaskets, portable gas tanks and the like.

- CAMERA TIME DELAY CIRCUIT: No modification of the shutter trip control mechanism is said to be necessary when this circuit is used to increase the time delay in a camera control system.

- OPTICAL RADAR SIMULATOR: This invention covers an apparatus and method for simulating radar systems and photographing optical echo signals for analysis.

- TRANSIT-TIME ACCELEROMETER: This patent covers a device which is said to be capable of measuring linear acceleration in any direction.

- CONVEYOR-BELT SORTER: This patent describes a conveyor-belt sorter for sorting data-bearing cards into pockets selected in accordance with a binary code.

- COOLING SYSTEM PROCESS: This patent covers a method of inhibiting corrosion in an acid-cleaned cooling system.

TECHNICAL TRENDS

□ The Business and Defense Services Administration, Department of Commerce, Washington 25, D. C. has available (at 10 cents each) brief reports on the market for U. S. Microwave, forward scatter and other radio communications equipment and radar in Mozambique and the Netherlands. /// The same organization has available single free copies of Announcement BD 61-123 detailing a 10 percent drop in United Kingdom exports of electronic products to the U. S. /// New appointments to the President's Science Advisory Committee include Dean E. R. Gilliland, Chemical Engineer Department, Massachusetts Institute of Technology; F. A. Long, Professor of Chemistry, Cornell University and Dr. C. M. MacLeod of the New York University Medical School. /// Among the purchases planned by the National Aeronautics and Space Administration are 12 preserved chimpanzee heads.

□ Details of a proposed purchase of 1,500 industrial diamond dies are available upon request from the Chief, Industry Branch, Defense Materials Service, GSA, Washington 25, D. C. /// Federal officials say more should be done in the field of highway research, pointing out that a 5 percent cost reduction could save the Federal Government (and taxpayers) some $150 million per year. /// A brief paper (IN-221) on safety performance tests for radioisotope sealed sources and devices is available on request from the Information Office, U. S. Atomic Energy Commission, Washington 25, D. C. /// The Superintendent of Documents, Government Printing Office, Washington 25, D. C. now has available (at 10 cents) the Complete Commercial Standard CS214-57 various structural plastics panels.

□ The Air Force has disclosed an incident in which two GAR-8 rockets were fired from an F-100 aircraft accidentally while safety switches were in the off-safe position. Investigation showed that the switch had a leakage resistance across the contacts leading to the jettison control relay. /// Harvard University has received a four-year $1.7 million contract from the Advanced Research Projects Agency of the Defense Department for expanded research and teaching programs in the material sciences. Similar contracts are being made with Brown University, Stanford University, M.I.T. and the University of Chicago. /// The Federal Communications Commission, in Report No. 3803, proposes to revise its FM Broadcast rules and investigate such technical subjects as signal ratios, polarizations, directionalizing, receiver characteristics and the like.

□ The Commerce Department has confirmed that attempts are being made to reconcile the sharp differences generally expressed in Government and Industry on patent rights in U. S. Government research projects. Pending legislation, particularly in the Senate, would give the Government the entire title to such patents. /// The Air Force Special Weapons Center, Procurement Directorate, Kirtland Air Force Base, New Mexico, plans to issue a study contract for a study of the "Spacetime History of Fission Products" resulting from nuclear explosions. /// The Air Force has awarded Hughes Aircraft Co. a study contract for Ion Engine Ground Testing techniques. /// The Navy Bureau of Weapons has issued a large contract to Universal Cyclops Steel Corp. for research and development facilities to fabricate pilot plant quantities of refractory metals in an argon atmosphere. /// The Office of Naval Research plans to award a contract for development of instrumentation for a moon radioactivity experiment.

□ The Department of Defense has awarded a $990,000 grant to the University of Illinois, Coordinated Science Laboratory, for acquisition of a large digital computer. /// Tests by Boeing Aero-Space Division, Seattle 24, Washington indicate that special sunlight concentrators of anodized aluminum can bring about a 45 percent increase in the amount of electricity silicon solar cells produce from sunlight. /// The Navy is exploring ways and means of sea-launching a space probe from the area of the North Pole for studies of the Van Allen radiation belts. One possibility is the use of an abbreviated Scout launching vehicle towed under the polar icecap by a submarine.

PUBLICATION CHECKLIST

- NATIONAL BUREAU OF STANDARDS, testimony, statements and exhibits on the critical need for high precision measuring equipment in the Space Age, as presented to Congress by officials of the National Bureau of Standards. 68 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Building, Washington 25, D. C. for NBS Hearing - No. 9)

- NICKEL BASE SUPERALLOYS, a discussion of available materials which are being used on the X-15 rocket research plane, and are being designed into advanced projects such as Dyna-Soar and Space Ferry. 40 Pages. (DMIC Report No. 153 available to Government agencies, their contractors, subcontractors and suppliers from Defense Metals Information Center, Battelle Memorial Institute, Columbus 1, Ohio)

- SL-1 ACCIDENT, an Investigating Board Report on the accident, fatal to three persons, at the SL-1 Reactor, National Reactor Testing Station in Idaho -- the first fatal power reactor accident in the U. S. 173 Pages. (Write Joint Committee on Atomic Energy, F-88, The Capitol, Washington 25, D. C. for "SL-1 ACCIDENT Report")

- OPERATING AIRCRAFT FROM UNPREPARED FIELDS, a NATO report on unprepared landing areas, soil and surface characteristics, landing gear design criteria, and an attempt to classify aircraft suitable for such fields. 99 Pages. Single Copies Free. (Write National Aeronautics and Space Administration, 1520 H Street, N. W., Washington 25, D. C. for AGARDograph No. 45)

- ISOTOPE EFFECTS IN HYDROGEN COMPOUNDS, a monograph containing a consistent set of tables of thermodynamic properties of a large number of diatomic hydrides, deuterides and tritides for the ideal gas state at one atmospheric pressure. The tables grow out of research undertaken because of the significant role recently assumed by the isotopes of hydrogen as research tools. 271 Pages. $2.75. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. regarding NBS Monograph No. 20)

- IMPORTANT AREAS OF ELECTRONICS RESEARCH, a Defense Department compilation of comments by industrial, university and governmental authorities on the many areas deemed worthy of investigation. 84 Pages. Single Copies Free while available. (Write Office of Electronics, Office of the Director of Defense Research and Engineering, The Pentagon, Washington 25, D. C.)

- POWER SUPPLIES, a bibliography compiled by the Armed Services Technical Information Agency of literature dealing with fuel cells, guided missile and space vehicle power supplies, batteries, etc. 313 Pages. (Power Supplies -- An ASTIA Report Bibliography available through military channels or at $5 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

- UNIVERSITY OF ILLINOIS ENGINEERING EXPERIMENT STATION, a new cumulative index of publications covering the period 1904-1960 and issued by this leading research organization. 43 Pages. Single Copies Free. (Write Engineering Publications, 114 Civil Engineering Hall, University of Illinois, Urbana, Ill. for Catalog)

- ENGINEERING COLLEGE RESEARCH REVIEW, the 1961 edition of this standard reference work presenting a detailed summary of current research programs and personnel in major U. S. engineering colleges. 476 Pages. $4. (Write W. L. Collins, Secretary, ASEE, Urbana, Ill. for Engineering College Research Review--1961)

- NIH DIRECTORY, the new third edition of the annual directory and bibliography of the National Institutes of Health. (Write Public Information Section, Office of Research Information, National Institutes of Health, Bethesda, Md.)